Silica Dust Exposure

Occupational Safety & Health Bureau

Montana Department of Labor & Industry

Prepared for Montana Employers
by the

Occupational Safety & Health Bureau
Department of Labor and Industry
P.O. Box 1728
Helena, Montana 59624-1728
(406) 444-6401

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Introduction

Exposure to dust containing silica can cause silicosis, a progressive, irreversible, and sometimes fatal lung disease. Every year more than one million American workers are exposed to silica dust at their jobs. Deaths from silicosis currently number about 300 cases per year. Hundreds more are being permanently disabled by this disease. Every one of these cases is an unnecessary tragedy, because silicosis is absolutely preventable.

If you work or are an employer in one of the many occupations where dust containing silica is present, you need to know how to prevent this disease and save your life or other workers' lives. Employers, safety supervisors, and foremen should work together to develop a silica exposure control program (see Appendix B. Example Silica Dust Control Program) to protect their workers.

This booklet can be used as a guideline for developing a silica exposure control program. It is not a substitute for any Occupational Safety and Health Administration (OSHA) standards. This booklet will:

- Explain what silica is;
- Identify industries and occupations that can be exposed;
- Describe silicosis and other health effects of silica;
- List permissible exposure levels of silica;
- Discuss recommended control procedures; and
- List guidelines for developing a silica exposure control program.

I. Silica – "It's not just dust"

Crystalline silica, also called alpha silica or free silica, is silicon dioxide (SiO2). In pure, natural form, SiO2 crystals are tiny, very hard, translucent, and colorless. Silica is the second most common mineral in the earth's crust and is a major component of sand, quartz, granite, and mineral ores.

The three most common types of crystalline silica encountered in industry are quartz, tridymite, and cristobalite. Silicates, composed of SiO2, are also a source of silica (usually less than 1%). Silicates include: mica, soapstone, talc, tremolite, and Portland Cement.

Quartz content can vary greatly among different rock types, for example: granite can contain anywhere from 10 to 40% quartz; shales have been found to average 22%, and sandstone average almost 70 % quartz.

II. Occupations at risk to silica exposure

Any occupation where workers are handling rock, brick, sand, or drilling, quarrying, or tunneling through the earth's crust may expose workers to silica. Silica is present in almost every process where natural minerals are handled. Employers and workers in the following occupations can be exposed to silica dust in various levels.

- Construction: sandblasting, rock drilling, masonry work, jack hammering, tunneling;
- Mining: cutting or drilling through sandstone and granite;
- Foundry work: grinding, moldings, shakeout, core room;
- Ceramics, clay, and pottery;
- Stone cutting: sawing, abrasive blasting, chipping, grinding;
- Glass manufacturing;
- Agriculture;
- Railroads: setting and laying track;
- Manufacturing and use of abrasives;
- Manufacturing of soaps and detergents;
- Shipyards: abrasive blasting;
- Rock crushing and transport: sand and gravel operations;
- Demolition of concrete and masonry structures;
- Dry sweeping or pressurized air blowing of concrete or sand dust;
- Cement and asphalt pavement manufacturing: concrete mixing, tunneling, and cutting;
- Paper and pulp mills: repair or replacement of linings of rotary kilns;
- Food processing operations: preparing crops for market, sorting, grading, and washing.

Workers encounter high-risk silica exposures through sandblasting, rock drilling, and mining. Workers who remove paint and rust from buildings, bridges, tanks, and other surfaces; clean founding castings; work with stone or clay; etch or frost glass; and work in construction are at risk of overexposure to crystalline silica.

III. Health effects of silica dust

Silicosis has taken a serious toll in the United States, attacking workers in many settings. Here is a real-life story.

A West Virginia driller will not see his 10-year-old daughter grow up. He will not be there when she gets married. He will not be there when she starts a family of her own. Her children will not have a grandpa to go fishing with. During the fall of 1988 a driller in his late 40's had chest pain. So he went to a hospital in Morgantown, West Virginia. The doctors told him he had silicosis (lung damage). He continued to work to support his family as many workers do. He died from silicosis during the spring of 1994 after 18 years of drilling. After his death his lungs were examined and were found to be hard because of all the dust in them. It was difficult to cut them even with a scalpel. *(NIOSH- Important Information for Construction Workers on Deadly but Preventable Dust Exposure)

A. Silicosis

Silicosis is lung damage caused by breathing dust containing fine particles of crystalline silica. If silica particles are inhaled they become embedded in the lungs, the lung tissues reacts by developing fibrotic nodules and scarring around the trapped particles. The scare tissue makes the

lungs hard and stiff. The scaring can greatly reduce the function of the lungs making it difficult and sometimes painful to breathe.

Not only does silica tear up the lungs but it also reduces the body's ability to fight off infections making workers more susceptible for developing other lung illnesses and infections. If workers smoke, silica exposure may greatly increase the risk of developing lung cancer. The incidence of tuberculosis is high among silicosis victims.

Symptoms of silicosis

Early stages of the disease may go unnoticed. Early symptom of silicosis can include:

- Shortness of breath during physical exertion;
- Fever; and
- Occasionally bluish skin at the ear lobes or lips.

Progression of silicoses can lead to:

- Fatigue;
- Labored breathing;
- Loss of appetite;
- Pain in the chest; and
- Respiratory failure, which may cause death.

In severe cases, fibrous tissue can hinder the flow of blood in vessels of the lung and the heart can enlarge in an effort to pump more blood. Death can result from cardiopulmonary effects of chronic silicosis.

Chronic silicosis, the most common form of the disease, may go undetected for years in the early stages. Chest x-rays may not reveal an abnormality until after 15 or 20 years of exposure. If you believe you are overexposed to silica dust, visit a doctor who knows about lung diseases. The progress of silicosis can only be stopped; but cannot be cured.

Silica dust can also irritate worker's eyes. Goggles or safety glasses should be worn if eye irritation is a problem.

IV. Permissible Exposure Levels

The current OSHA permissible exposure limit (PEL) for crystalline silica respirable dust is 10 milligrams silica per cubic meter of air (mg/m^3) divided by the percent silica in the dust +2. For total dust the PEL is 30mg/m^3 divided by the percent silica in the dust +2. The formula is found in Table Z-3 of 29 CFR 1910.1000.

$$\textbf{PEL (mg/m}^3\textbf{), respirable dust} = \frac{\textbf{10 mg/m}^3}{\textbf{(\%SiO2 + 2)}}$$

For example, to calculate the PEL for a sample of respirable dust containing 5.0 % SiO2, substitute 5.0 % in the formula.

$$\text{PEL} = \frac{10\text{mg/m}^3}{(5.0+2)} = 1.4\ \text{mg/m}^3$$

NIOSH has recommended a PEL of 0.05mg/m^3 for a 10-hour shift, 40 hours per week. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends the following levels for respirable fraction of the dust.

- 0.05mg/m^3 for cristobalite
- 0.1mg/m^3 for quartz
- 0.05mg/m^3 for tridymite
- 0.1mg/m^3 of contained tripoli respirable quartz

V. Control of Silica Dust Exposures.

The key to preventing silicosis is preventing silica dust from being in the air. Employers are required to provide and assure the use of appropriate controls for dusts containing crystalline silica.

A. Engineering Controls

OSHA 29 CFR 1926.55 states, "… to achieve compliance with the established PEL, the employer must first implement engineering controls or administrative controls whenever feasible."

1. Wet work

- Airborne silica dust can be minimized or reduced by applying water to the process or clean up.

- When sawing or drilling concrete or masonry use saws/drills that provide water to the blade.

2. Isolation

- Use containment methods such as blast-cleaning cabinets when sandblasting.

- Cabs of vehicles or machinery cutting or drilling through rock that might contain silica should be enclosed and sealed.

3. Ventilation

- Use local exhaust systems to remove silica dust from industrial processes.

- Dilution ventilation may be used to reduce the silica dust concentration to below the PELs in large areas.

- Adequate measures should be taken to ensure that any discharge would not produce health hazards to the outside environment. A dust collector should be set up so that accumulated dust can be removed without contaminating work areas.

- Routinely maintain ventilation systems to keep them in good working condition.

4. Dust Control

- A vacuum with a high-efficiency particle air (HEPA) filter can be used to remove dust from work areas.

5. Substitution

- Do not use silica sand or other substances containing more than 1% crystalline silica as abrasive blasting materials. Substitute with less hazardous materials.

B. Administrative Controls

1. Air Monitoring: Air monitoring must be preformed to determine exposures, evaluate engineering controls, selecting respiratory protection, evaluate work practices, and determine the need for medical surveillance.

- Exposure measurements should be made in the employee's actual breathing zone.
- Any appropriate combination of long-term or short-term respirable samples is acceptable.
- Total sampling time must be at least 7 hours.
- Monitoring should be repeated at least quarterly.

2. Training: Workers should be trained in the following:

- The health effects of silica dust exposure;
- Operations and material that produce silica dust hazards;
- Engineering controls and work practice controls that reduce dust;
- The importance of maintenance and good housekeeping;
- The proper use of respirators and personal protective equipment;
- Personal hygiene practices to reduce exposure; and
- Details of the employer's hazard communication and crystalline silica program.

3. Housekeeping: Remove dust on overhead ledges, on floors, and equipment before it becomes airborne due to traffic, vibration, and random air current.

- Never dry sweep or use compressed air for clean up of dust that may contain silica.
- Use wet methods or vacuums with a HEPA filter for clean up.
- Gentle washdown of surfaces is preferable if practical.

4. Personal Hygiene: Practice good personal hygiene to avoid unnecessary exposure.

- Hand-washing facilities should be conveniently located throughout a worksite in order to minimize worker contact.

- Lockers should be provided for employees to store uncontaminated clothing.

- Workers should shower (if possible) and change out of work clothes contaminated with silica dust before they leave the jobsite. Wearing work clothes home covered in silica dust can expose the workers family to the hazard.

- Work clothes should not be cleaned by blowing or shaking. They should be vacuumed with a HEPA filter vacuum before removal.

- Locate eating/lunch areas away from exposed areas.

- Workers should park their cars where they will not be contaminated with silica.

5. Restricted areas

- Post warning signs in areas where silica exposure already exists or is possible.

- Unauthorized employees should not be allowed in restricted areas.

- Warning signs should contain the following information:

WARNING
SILICA DUST HAZARD

SILICA DUST CAN CAUSE SILICOSIS

Respirators Required

6. Provide medical examinations

- Employers should provide medical examinations for employees who may be exposed to respirable crystalline silica.

- Medical exams should include chest X-rays, pulmonary function tests, and tuberculosis test.

- Chest X-rays should be read by a specialist in dust diseases.

- Develop a plan for reducing exposures of employees whose X-rays show changes consistent with silicosis. Ordinarily, this is accomplished by removal from jobs or tasks involving crystalline silica exposure, but in some cases it may be accomplished by the effective use of supplied air respirators.

7. Report cases

- All cases of silicosis should be reported to state health departments and recorded on OSHA logs, as required.

C. Personal Protective Equipment

Personal Protective Equipment (PPE) should only be used when engineering and administrative controls do not provide adequate worker protection and reduce the PELs below recommended limits. PPE is the last line of defense for fighting silicosis.

Respiratory Protection

Only when all engineering or administrative controls have been implemented, and the level of respirable silica still exceeds permissible exposure limits, may an employer rely on a respirator program to protect workers. The respirator program must comply with the OSHA standards for respiratory protection 1910.134 and 1926.103.

- The employer must select and provide an appropriate respirator that will effectively protect their employees (see Appendix A). When abrasive blasting is done, the type C supplied-air, positive pressure, demand type abrasive blasting respirator shall be worn according to 29 CFR 1910.94(a).

- Respirators must be approved by NIOSH under 42 CFR part 84 for protection against the specific type of dust encountered.

- An abrasive-blasting respirator must cover the wearer's head, neck, and shoulders to protect from rebounding abrasives.

- The respirator program outlined in 1910.134 must be strictly followed to protect workers and comply with OSHA standards.

D. Crystalline Silica Protection Program

A silica protection program is an effective tool that can be used by employers committed to protecting their workers from silicosis (see Appendix B Example Silica Protection Program). The following is a list of elements which need to be included in an effective crystalline silica protection program:

- Ongoing personal air monitoring program
- Ongoing medical surveillance program
- Training and informing workers on hazards of silica dust.
- Availability of air and medical surveillance data to workers.
- Engineering controls and a scheduled maintenance program.
- Work practice controls
- An effective respiratory protection program
- Hygiene facilities and clothing change areas
- Appropriate recordkeeping
- Housekeeping program
- Regulated areas.

State Occupational Safety and Health Consultation Project

The Montana Onsite Consultation Project is a source of assistance with construction and general industry safety and health. This division of the Department of Labor and Industry operates independently of OSHA's enforcement branch. The program was developed with small businesses in mind, and is available to private sector employers who want help in recognizing and correcting jobsite hazards.

When an employer uses the service, a trained occupational safety and health professional conducts a free onsite "inspection" and consultation. No citations or penalties are given for any of the problems that the inspector/consultant may find, and the service is completely confidential. The employer has the responsibility and obligation through the program to correct the identified hazards within an allotted amount of time. In addition, the consultant can assist in developing and maintaining an effective safety program, offer jobsite training and education for employees, and help locate other sources of assistance for safety and health concerns.

Although this program can be beneficial, you must realize that there is still no guarantee that a jobsite that has received the consultation services will "pass" an OSHA inspection. For information about Montana's Onsite Consultation Project please contact:

Safety & Health Bureau
Department of Labor and Industry
P.O. Box 1728
Helena, MT 59624-1728
(406) 444-6401

Web Sites and Contact Numbers

1. **National Institute for Occupational Safety and Health**, **(NIOSH)**. Department of Health and Human Services, 200 Independence Ave. SW317B, Washington, DC, 20201.
1-800-356-4674, 1-800-35-NIOSH.
www.niosh.gov

2. U.S. Department of Labor, **Occupational Safety & Health Administration**, **(OSHA)**. Public Affairs Office- Room 3647, 200 Constitution Ave. Ashington, D. C. 20210.
1-202-693-1999.
www.osha.gov

3. **American Conference of Governmental Industrial Hygienists**, **(ACGIH).** 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634.
1-513-742-2020
www.acgih.org

Appendix A.

Respiratory Selection Chart for Crystalline Silica Dust

Particulate Concentration	Minimum Respiratory Protection* Required Above X** mg/m^3
5X** mg/m^3 or less	Dust respirator
10X**mg/m^3 or less	Dust respirator, except single-use or quarter-mask respirator Fume respirator or HEPA filter respirator Self-contained breathing apparatus (SCBA)
50X**mg/m^3 or less	HEPA filter respirator with a full facepiece Supplied-air respirator with a full facepiece, helmet, or hood SCBA with full facepiece
500X**mg/m^3 or less	Powered air-purifying respirator with a HEPA filter. Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 500X**mg/g^3 or entry and escape from unknown concentrations	SCBA with a full facepiece operated in pressure demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary SCBA operated in pressure-demand or other positive pressure mode.

*Only NIOSH-approved or MSHA-approved equipment should be used
**X indicates the permissible exposure as defined above

Appendix B. Example Silica Dust Exposure Control Program

This is a sample program; employers must develop their own program specific to their industry or worksite.

ABC Company Occupational Silica Dust Exposure Control Program

ABC Company recognizes that exposure to silica dust can cause silicosis (a deadly lung disease) and may cause lung cancer. ABC Company takes responsibility for protecting the safety and health of its employees.

The Occupational Silica Dust Control Program includes the following parts:
1. Hazard Identification
2. Worksite Air Monitoring
3. Employee Training
4. Housekeeping Procedures
5. Engineering Controls
6. Personal Hygiene
7. Personal Protective Equipment
8. Medical Examinations and Evaluation
9. Recordkeeping
10. Emergency First Aid Procedures for Silica Dust
11. Spill and Disposal Procedures

Part 1. Hazard Identification

ABC Company recognizes that the following jobs/task can produce silica dust hazards at our workplace (sandblasting, concrete cutting, determine hazards for each site)_____
_____
_____.

When any of these jobs/tasks are preformed by a worker employed by ABC Company they will be protected by the Occupational Silica Dust Exposure Control Program.

__(Name, Supervisor)____ is responsible for identifying silica dust exposure hazards.

Part 2. Worksite Monitoring

When a job/task is identified as a silica dust hazard the process and the worker's breathing zone will be monitored for silica dust concentrations. Employee exposure measurements must represent actual breathing zone exposure conditions for each employee.

Each job/task identified in part one will be monitored every four months and whenever a change is made to the process. Engineering controls will be monitored immediately after implementation and quarterly thereafter.

Employees will be able to view all air monitoring records; copies of the records can be found at __(Location)_____.

__(Name)_____ is responsible for the worksite monitoring program.

Part 3. Employee Training

All employees working in the jobs/tasks identified in part one are required to complete a training course prior to working in the exposure area. Workers will be trained when first assigned to the job/task and annually thereafter.

Training for Occupational Silica Dust Exposure will include the following topics:

1. Health hazards of silica dust exposure (including signs and symptoms of silicosis.
2. Operations and materials that can produce silica dust exposures.
3. Engineering and work practice controls used to protect them from exposures.
4. The importance of proper equipment and control maintenance.
5. Housekeeping procedures.
6. Proper use of respirators and the respirator standard.
7. Personal hygiene procedures to reduce exposures.
8. How smoking increases the risk of developing silicosis and other lung damage.
9. The details of the Occupational Silica Dust Exposure Program.

Training will be performed by __(Name)_____. Records of attendance, dates of training, and training material will be documented and located at _____.

Additional training or reference material on silica dust exposure will be made available upon request to employees.

Part 4. Housekeeping Procedures

Dry sweeping and the use of compressed air are **prohibited** for removing dust in jobs/task identified in part one. Work areas and equipment covered by dust will be cleaned at the end of every shift by using a HEPA filter vacuum. Vacuums are stored at _____.
Wet clean up may also be used to remove dust.

Waste material will be stored at _____ and will be removed at least weekly. Supervisors are responsible for ensuring that work areas are free from dust at the end of each shift.

Part 5. Engineering Controls

ABC Company will use engineering controls whenever possible to control silica dust exposures.

Ventilation systems will be inspected and maintained by _____.
Ventilation systems will be checked at least weekly to determine if they are functioning properly.

ABC Company will not use abrasives that contain more than 1% crystalline silica during blasting operations.

_____ is responsible for inspecting and maintaining engineering controls at all jobs/tasks identified in part one.

Part 6. Personal Hygiene

Employees working at the jobs/tasks identified in part one will change out of contaminated clothing and work boots before leaving the jobsite. Contaminated clothing will be vacuumed with a HEPA filter vacuum to remove silica dust. Vacuums will be located at _____.

Lockers or containers will be provided to store clean clothes at the jobsite. Employees are required to wash their hands and shower (when feasible) before leaving the worksite. Showers are located at _____; hand washing facilities are located at _____. When worksites are located in the field away from normal operation ABC Company will provide water in portable containers to hand washing.

Employees will not eat, smoke, or use smokeless tobacco in areas identified in part one.

Part 7. Personal Protective Equipment

When respirators are required to protect employees for silica dust exposure ABC Company's Respirator Program will be strictly followed. Copies of the Respirator Program are located at _____.

Part 8. Medical Surveillance

All workers working in jobs/tasks identified in part one will be given medical examinations to prevent the development of silicosis. Medical examination will be conducted once a year for employees working in jobs/tasks that expose them to silica dust.

Medical examination must include (1) Chest X-rays, (2) Pulmonary function tests, and (3) tuberculosis evaluation. Medical examinations will be performed by ___(doctor or health physician)____.

Employees whose chest X-rays show changes consistent with the development of silicosis are customarily removed from jobs/tasks that expose them to silica dust. Input from the attending physician will be considered in making this decision.

Medical records will be made available at _____.

Part 9. Recordkeeping

Training, medical records, air monitoring, engineering control maintenance records, and injury records will be kept and located at _____.

__(Name)_____ is responsible for the recordkeeping program.

Part 10. Emergency First Aid Procedures for Silica Dust

1. *Eye Exposure*

   If crystalline silica dust gets into the eyes, wash immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Portable eyewashes will be kept at jobsites in the field away from the company locations.

2. *Breathing*

   If a person breathes in large amounts of crystalline silica dust, move the exposed person to fresh air immediately. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

Part 11. Spill and Disposal Precautions

If crystalline silica is spilled or released in hazardous concentrations, the following steps will be taken:

1. Ventilate the area of the spill or release.
2. Persons doing the clean-up are required to wear appropriate respirators.
3. Collect spilled material in the most convenient and safe manner for reclamation or disposal in a secured sanitary landfill.

I have read and understand the requirements of this program and will participate in all training and safety precautions.

Employee Signature _____ Date:_____